REMARKS

The Examiner is thanked for the thorough examination of the present application. The Office Action has, however, tentatively rejected all pending claims 32-45. In response, Applicant has amended claim 32 to more clearly define novel and non-obvious features of the claimed embodiment. Specifically, claim 32 is amended to add the limitations of "performing a first exposure, with an alternating phase shift mask with full size scattering bars, on the substrate" and "performing a second exposure, with a tritone attenuated mask having at least one scattering bar, on the substrate, wherein said scattering bars are not printed in the feature from the second exposure". Support for these features can be found at least on pages 10-13 of the application. Accordingly, Applicant submits that no new matter has been added.

Rejections Under 35 U.S.C. 112

Claims 32-45 stand rejected under 35 U.S.C 112, second paragraph, as allegedly indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Specifically, the Office Action stated that the phrases "the resulting pattern" and "the lithography process" lacked antecedent basis. Applicant has amended claim 32, and as amended claim 32 is believed to fully comply with all statutory requirements, including all paragraphs of 35 U.S.C. 112.

In this regard, amended claim 32 recites "said scattering bars are not printed in the feature from the second exposure", wherein "feature" and "second exposure" were previously introduced.

Rejections Under 35 U.S.C. 102(b)

Claims 32-36 stand rejected under 35 U.S.C 102(e) as allegedly anticipated by Smith (US Pub. 2002/0186356). Claim 32 stands rejected under 35 U.S.C 102(e) as allegedly anticipated by Peterson (US Pub. 2002/0015900). Claim 32 stands rejected under 35 U.S.C 102(e) as allegedly anticipated by Smith (USP 6673638). Applicant respectfully traverses the rejections for at least the reasons discussed below.

Amended claim 32 recites "performing a first exposure, with an alternating phase shift mask with full size scattering bars, on the substrate" and "performing a second exposure, with a tritone attenuated mask having at least one scattering bar, on the substrate, wherein said scattering bars are not printed in the feature from the second exposure" of the claimed invention. This unique feature is to expose the substrate utilizing ***series of two different exposure steps*** with ***two different photomasks***. (See pages 10-13 and Fig. 8.)

Rejections by Smith

Smith does not teach or suggest exposing the substrate utilizing ***series of two different exposure steps*** with ***two different photomasks*** as "performing a first exposure, with an alternating phase shift mask with full size scattering bars, on the substrate" and "performing a second exposure, with a tritone attenuated mask having at least one scattering bar, on the substrate, wherein said scattering bars are not printed in the feature from the second exposure," as required by the claimed embodiments.

In page 2, the Office Action asserts that Smith discloses a first exposure with an APSM with full size scattering bars (fig 5-10, 14-15, para 0062) and a second exposure with a tritone attenuated mask having at least one scattering bar (para 0059-0060, 0070), said scattering bars

are not printed in the resulting pattern from the lithography process (para 0058, 0060, 0062, 0076, 0013, 0020, 0052).

In Figs. 5(a)-5(e) and para 0058 of Smith, Figs. 5(b)-5(e) illustrate resulting diffraction patterns for gray bar assist features 18 utilized in the mask illustrated in Fig. 5(a), and four variations of the gray bar assist features 18 are illustrated in Figs. 5(b)-5(e), 100% transmission in Fig. 5(b), 50% transmission in Fig. 5(c), 25% transmission in Fig. 5(d), and 0% transmission in Fig. 5(e). Smith, however, fails to teach or suggest that the steps in Figs. 5(b)-5(e) are performed in series. On the contrary, as described in para 0058, illustrated in Figs. 5(b)-5(e) are for comparison between the values of the diffraction orders illustrated therein. According thereto, those skilled in the art acknowledge that the steps illustrated in Figs. 5(b)-5(e) are performed independently, but not necessarily in series.

In Figs. 6(a)-6(c) and para 0060 of Smith, the influences to the primary diffraction orders due to the gray bar assist features are shown, wherein Fig. 6(a) shows the influences to the zero order magnitude, Fig. 6(b) shows the influences to the first order magnitude, and Fig. 6(c) shows the influences to the second order magnitude. Thus, Smith ***fails to teach or suggest*** that shown in Figs. 6(a)-6(c) ***result from series exposure to the same substrate with two different photomasks***. The transmission of the gray bars is variable from 0 to 100%. As shown in Figs. 6(a)-6(c), influences due to gray bars of variable transmission values are compared. Smith still ***fails to teach or suggest*** photomasks with gray bars of variable transmission values ***are utilized to expose the same substrate in series***.

In para 0061, Smith describes that the feature width and spacing and the imaging conditions utilized in conjunction with the images of Figs. 7(a)-7(c) are ***the same as*** those

described above in conjunction with the images of Figs. 6(a)-6(c). Thus, Smith fails to teach or suggest the steps in Figs. 6(a)-6(c) and Figs. 7(a)-7(c) **are performed in series**.

In para 0064, Smith describes Figs. 8(a)-8(d) illustrate ***simulated aerial images*** for a 150 nm wide feature. Further, Fig. 8(a) illustrates the results without utilizing any gray bar assist features, Fig. 8(b) corresponds to a 0% transmission gray bar with a 0.17 fractional width, Fig. 8(c) corresponds to a 25% transmission gray bar with a 33% fractional width, and Fig. 8(d) corresponds to a 44% transmission gray bar with a 50% fractional width. As described those shown in Figs. 8(a)-8(d) compare the influences due to variable transmissions and fractional widths of the gray bar, and Smith still ***fails to teach or suggest*** the steps in Figs. 8(a)-8(d) are ***performed in series***. Moreover, Smith fails to teach or suggest those shown in Figs. 8(a)-8(d) is an exposure step in series with those shown in Figs. 5-7.

In para 0065, Smith describes Fig. 9 illustrates how the gray bar assist features can be tuned to further decrease the isofocal inflection point **in comparison to** the reduction illustrated in Fig. 8(d). As described, Smith fails to teach or suggest that shown in Fig. 9 is an exposure step in series with that shown in Fig. 8(d) or those shown in Figs 5-8.

In para 0066, Smith describes FIG. 10 illustrates **the effect of various gray bar assist features** on a 150 nm feature having a line : space duty ratio of 1:2.5. As shown in each of the four examples, the use of the gray bar assist feature provides an improvement by reducing the isofocal inflection point and the resulting CD of the 1:2.5 feature to closer to that of the 1:1 feature. As described, Smith fails to teach or suggest that shown in Fig. 10 is an exposure step in series with that shown in Fig. 9 or those shown in Figs 5-8.

In para 0072, Smith describes FIGS. 14(a)-(c) are plots of the primary diffraction orders resulting from the combination of an opaque assist bar (scatter bar) with APSM for features

having a 1:2.5 line : space duty ratio, wherein APSM values are varied from 0% (binary) to 20%, and The scatter bar widths are varied from zero to the full space width. As described, Smith ***fails to teach or suggest*** the steps in Figs. 14(a)-14(c) are ***performed in series***. Moreover, Smith fails to teach or suggest those shown in Figs. 14(a)-14(c) is an exposure step in series with those shown in Figs. 5-10.

In para 0073, Smith describes FIGS. 15(a)-(c) are of the zero, normalized first and normalized second diffraction order values, respectively, for a feature having a 1:2.5 line : space duty ratio and 6% APSM with various gray bar widths and gray bar transmissions, and FIGS. 15(d)-(f) illustrate the same, with the exception being the use of 18% APSM. As described, Smith ***fails to teach or suggest*** the steps in Figs. 15(a)-15(f) are ***performed in series***. Moreover, Smith fails to teach or suggest those shown in Figs. 15(a)-15(f) is an exposure step in series with those shown in Figs. 5-10, 14.

In para 0020 and 0076, Smith describes certain advantages of his invention, but fails to teach or suggest any exposure steps in series. In para 0013, Smith describes what U.S. Pat. No. 5,821,014 discloses, but fails to teach or suggest any exposure steps in series. In para 0052, Smith describes provision of a method for achieving the foregoing objective so as to allow dense and non-dense features to be printed utilizing the same process window, while simultaneously minimizing the likelihood that the assist features will print, but fails to teach or suggest any exposure steps in series.

As described, Smith fails to teach or suggest exposing the substrate utilizing ***series of two different exposure steps*** with ***two different photomasks*** as "performing a first exposure, with an alternating phase shift mask with full size scattering bars, on the substrate" and "performing a second exposure, with a tritone attenuated mask having at least one scattering bar, on the

substrate, wherein said scattering bars are not printed in the feature from the second exposure" of the claimed invention.

Rejections by Peterson

Peterson does not teach or suggest exposing the substrate utilizing ***series of two different exposure steps*** with ***two different photomasks*** as "performing a first exposure, with an alternating phase shift mask with full size scattering bars, on the substrate" and "performing a second exposure, with a tritone attenuated mask having at least one scattering bar, on the substrate, wherein said scattering bars are not printed in the feature from the second exposure" of the claimed embodiments.

In para 0024, Peterson describes several techniques and combinations thereof adjust the complex transmittance of the features, and is based on producing the highest fidelity and most robust image in the photoresist while maintaining design rules so that the photomask can be manufactured in a reliable fashion, but fails to teach or suggest any exposure steps in series.

In para 0052, Peterson describes FIGS. 7a-7i show different embodiments of the invention for a primary feature with a single pair of assist features, but fails to teach or suggest any exposure steps in series. Peterson still fails to teach or suggest photomasks shown in Figs. 7(a)-7(i) are utilized in series exposing a substrate.

In para 0054, Peterson describes FIG. 8 shows a top-down view of an isolated primary feature 10 with phase-shifted halftone assist features 22a, 22b of the embodiments of FIGS. 7a-7i, and FIGS. 9a and 9b show cross-sections of an isolated feature 10 with the trenches of the phase-shift assist features 22a, 22b, but fails to teach or suggest any exposure steps in series.

As described, Peterson fails to teach or suggest exposing the substrate utilizing ***series of two different exposure steps*** with ***two different photomasks*** as "performing a first exposure, with an alternating phase shift mask with full size scattering bars, on the substrate" and "performing a second exposure, with a tritone attenuated mask having at least one scattering bar, on the substrate, wherein said scattering bars are not printed in the feature from the second exposure" of the claimed embodiments.

Rejections by Pedik et al.

Pedik et al. do not teach or suggest exposing the substrate utilizing ***series of two different exposure steps*** with ***two different photomasks*** as "performing a first exposure, with an alternating phase shift mask with full size scattering bars, on the substrate" and "performing a second exposure, with a tritone attenuated mask having at least one scattering bar, on the substrate, wherein said scattering bars are not printed in the feature from the second exposure" of the claimed invention.

In Col. 1, line 60+, Pedik et al. describe scatter bars improve lithographic behavior of small isolated and quasi-dense features by adjusting the shape of the aerial image--simply an extension of OPC technology, but fails to teach or suggest any exposure steps in series. In Col. 4, line 53+, Pedik et al. describe Serifs 112 (shown in Fig. 1), added to test structure features 102 to reduce corner rounding and feature length shortening on the printed pattern, are examples of subresolution assisting features, i.e., features appearing on the reticle which help control the printing of the test structure features onto the printed wafer but do not themselves appear in the printed test structure, but likewise fails to teach or suggest any exposure steps in series.

In Col. 6, lines 43-46, Pedik et al. describe FIGS. 2A-2B illustrates this range of sensitivities in a patterned wafer 206 having a die 208 formed using the array 100 from the reticle shown in FIG. 1, but fails to teach or suggest ***series of two different exposure steps*** with ***two different photomasks*** as defined in the claimed embodiments.

Pedik et al. describe FIG. 7A as illustrating a conventional dual toned line shortening array printed at best focus, and FIG. 7B as illustrating the plot of the critical dimension vs. focus produces a best-fit curve that is symmetrical about the best focus point respectively in Col. 10, lines 38-40, and Col. 11, lines 43-45. Pedik, however, fails to teach or suggest ***series of two different exposure steps*** with ***two different photomasks,*** as defined in the claimed embodiments.

Pedik et al. describe FIG. 8A illustrates an example of an OPC shifted (defocused) paired line shortening array 800, FIG. 8B illustrates the plot of the optically measured critical dimensions show a response centered at + or -0.2 micron for the defocused test structure, and FIG. 8C illustrates a sample determination of the direction of focus shift using a test structure printed at best focus and one printed in a defocused state, respectively in Col. 12, lines 14-15, 28-33, and 45-48, but fails to teach or suggest ***series of two different exposure steps*** with ***two different photomasks*** as the claimed invention.

As described, Pedik et al. fail to teach or suggest exposing the substrate utilizing ***series of two different exposure steps*** with ***two different photomasks*** as "performing a first exposure, with an alternating phase shift mask with full size scattering bars, on the substrate" and "performing a second exposure, with a tritone attenuated mask having at least one scattering bar, on the substrate, wherein said scattering bars are not printed in the feature from the second exposure" as defined in the claimed embodiments.

Conclusion

For at least the foregoing reasons, claim 32 (as amended) patently defines over the cited references. Insofar as claims 33-45 depend from claim 32, these claims are also allowable.

If, in the opinion of the Examiner, a telephonic conference would expedite the examination of this matter, the Examiner is invited to call the undersigned agent at (770) 933-9500.

No fee is believed to be due in connection with this amendment and response to Office Action. If, however, any fee is believed to be due, you are hereby authorized to charge any such fee to deposit account No. 20-0778.

Respectfully submitted,

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